Title: "Leveraging ISI Multi-Model Prediction for Navy Operations: Proposal to the Office of Naval Research"

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LONG-TERM GOALS

The potential to leverage existing and planned efforts to produce intra-seasonal to seasonal and interannual climate predictions, by U.S. national laboratories participating in the National Multi-Model Ensemble (NMME) project and by U.S. Navy research and operational entities, for the purpose of advising and enhancing Navy operations will be exploited. The proposed work will build on a review of the existing and planned efforts at the relevant U.S. Navy centers and will enhance existing operational climatological products developed by the Climatology Division at NRL-Monterey and will seek to include Navy models in the NMME project.

The accuracy, timeliness, and information content of Navy operational products intended to provide tailored long-range operational environmental information for planning and decision support can be significantly enhanced by the targeted application of dynamical ensemble predictions.

OBJECTIVES

Stream-2 of the NMME project is ideally suited for collaboration to enhance ongoing Navy efforts in providing operational climatological products and in developing the next generation Navy seamless weather and climate prediction system. We propose to foster this collaboration in two areas: operational climatological products and the development of the next generation prediction system.

APPROACH

We propose to developed methods and procedures by which the NMME Stream-2 data can be blended with the current use data sets to produce improved guidance. The development will focus on the top-10 ACAF requested products, as determined from our initial investigation of Navy requirements:

(1) Waves

(2) Winds

(3) Ceiling and visibility

(4) Precipitation

(5) Storm formation and tracks and (tropical and extra-tropical)

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(6) Evaporative duct heights

(7) Air temperature

(8) Freezing level(s)

(9) Sea surface temperatures

(10) Currents

While the hypothesis is simply stated, the implementation is challenging. In particular, the ISI predictability of some of these quantities is well known, while it has not been evaluated for others that are more commonly used in weather prediction than climate analysis.

For illustrative purposes, we first note some universal or overarching processes and analyses that will need to be developed and then we describe how we will evaluate using the NMME Stream-2 data to improve the provision of two of the top-10 ACAF requests. These two examples are chosen because they demonstrate contrasting approaches (i.e., statistical post- processing of forecast data vs. applying forecast data to drive or force application models) to using the NMME data.

Regardless of whether the NMME data are used via statistical post-processing or in forcing a specific application model, some universal processes and analysis will need to be developed and applied. To understand the challenges we note several characteristics of the required processing and analysis:

(1) The NMME Stream-2 data will include hindcasts and real-time forecasts, generated each month for 30 years, and for each hindcast or forecast there will be approximately 100 ensemble members.

(2) Depending on the field and the way it is used, the data will either be monthly, daily or 3-hourly, so that ingesting, formatting and quality controlling this data for Navy application requires substantial effort.

(3) The data will need to be bias-corrected and calibrated, which is typically done based on the hindcasts and may include simple linear corrections or more sophisticated techniques.

(4) The bias-corrected and calibrated NMME data will need to quality assessed against available observational estimates.

(5) The NMME data will need to be applied as done in ACAF or other application models (e.g., WW3) for the 30-year hindcast period.

(6) The NMME based climatological products will need to be evaluated against existing products to develop the best strategies for combing the products.

It should be noted that the fact that the NMME data includes approximately 100 ensemble members for each forecast means that rather detailed probabilistic information could be provided. Moreover, we also emphasize that the development of all of the processes and analyses requires close collaboration and interaction with the Climatology Division.

WORK COMPLETED

Worked completed includes: (i) Post-processing NMME (CCSM4) high-frequency data (surface winds) for predictability analysis and for focing WW3; (ii) installing and testing WW3 with both best

obervational estimates of surface winds; (iii) coordinating with Associate Professor Tom Murphree (NPS) in identifying key targets for predictability analysis that is of most benefit to The Climatology division at the Fleet Numerical Meteorology and Oceanography Center (FLENUMMETOCCEN); and (iv) participated in the scientific organizing committee for "Probing the Weather-Climate Interface Using Ensemble-based Prediction – Issues and Challenges" Scripps workshop (Cornuelle et al. 2013).

RESULTS

Nothing to report at this time. Project is in its early stages.

IMPACT/APPLICATIONS

Ultimately, our goal is to make the NMME results useful and used in Navy climatological operational support.

REFERENCES

Cornuelle, B., J. Hansen, B. Kirtman, and S. Sandgathe, 2013: Probing the Weather-Climate Interface Using Ensemble-based Prediction – Issues and Challenges. *Bulletin of the American Meteorological Society* (submitted).